THROUGH-LIFE RISK MANAGEMENT IN MEGA PROJECTS

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ABSTRACT

Mega Projects play a significant role in the UK construction industry. They provide infrastructure, business and employment opportunities for the nation. They are complex, and involve considerably high cost, and risk. Therefore, through-life risk management practices are considered as a mandatory consideration in mega projects. These risks arise in externally (political, economic, social, technological, environmental, legal, etc.) and/or internally (project, stakeholders, etc.), and the influence of such risks leads to a substantial cost overruns. Therefore, such risks need to be managed efficiently to endorse the project success. This study investigates the through-life risk management strategies that are adopted in the UK Mega Projects.

A literature review, four semi-structured interviews and a structured online questionnaire survey were the methods used to collect data. Interview data was analysed through NVivo and appropriate themes were developed. This was compared with the survey findings and conclusions were drawn accordingly. The findings explain that through-life risk management is a mandatory requirement in mega projects, and design and economic risk are the two most significant project risks that need to be addressed in advance. However environmental risks also play an important pre-requisite role in mega projects. Findings further explain risk register as a mandatory requirement for mega projects, which provides the opportunity for the project to keep track of all risk whether they have happened, will happened or currently happen.

Keywords: *Through-life Risk Management; Types of Risks; Strategy; Mega Projects; United Kingdom.*

1. INTRODUCTION

Mega projects are highly complex ventures, which usually take several years to design and construct. 'Mega' can be a scientific and technical unit of measurement which would be a million, so in economic terms, it would be a million-dollar (or euro, pound etc) project (Flyvbjerg, 2014). Literature explains the cost of mega projects range from £100M to over a billion pounds, due to their complexity, involvement of several public-private stakeholders, and the impact of such projects on the wider society (Oliomogbe and Smith, 2013). Mega projects are 'privileged particles of the development process', they are usually trait making, which means that they are intended to alter the structure of society unlike smaller and original projects that do not have an impact on the society at a wider spectrum (Hirschman, 1967 cited in Flyvbjerg, 2014). Mega projects contribute to 8% of the global gross domestic product. Flyvbjerg (2014) explains that cost of a few of the biggest mega projects in the world would dwarf most of the other economic and investment figure.

Mega projects play a pivotal part in the UK construction industry. They create opportunities such as absorbing the blue-chip clients/ companies into the UK, which would in turn draw investment for British lead schemes. For example, the London 2012 Olympics project had a budget of under £9 Billion pounds. PricewaterhouseCoopers (PwC) have declared that around $1.5 trillion of the $78 Trillion global investment fund for capital projects and infrastructure up to 2025 is intended for the UK (McClelland, 2015). The UK government intends to invest on megaprojects as agreed in their National Infrastructure Delivery plan 2016-2021. The plan further outlines that over £100 billion is dedicated to 2020-21, which is part of a £483 billion project pipeline. The government's intention was to set a robust foundation for better infrastructure, productive economy and improved society for many years to come. The UK has been considered for how mega projects

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are being delivered in a 'radically new way', and further adds that the United States and several European cities are 'watching' and 'learning' (McClelland, 2015).

There are several mega projects running across the UK and many of them are funded through the central Government. The risk attached to those projects are multifaceted and project specific. However, when it comes to mega projects the project itself is complex and cost/value driven. Therefore, correct risk management strategies should be implemented within these projects to minimise the damage (time, cost overruns, poor quality) as much as possible. There is plethora of literature to discuss the risk management in construction projects; however, limited attention has been paid on mega projects. Therefore, this study aims to bridge this gap by identifying the through life risk management strategies of mega projects.

The first section of the paper explains the nature and characteristics of mega projects, and the second section discusses the risk management approach in specific to mega projects. Having analysed the findings of interviews and surveys, the third section illustrate the significant risks associated with mega projects and adopted risk management strategies.

2. RESEARCH METHOD

The study adopted a multi-method approach to collecting data. A detailed literature review was undertaken to identify characteristics of mega projects and also the principles and practices of risk management in specific to construction context. An online questionnaire survey was conducted among the construction industry professionals to identify the most significant risks and the strategies for managing such risks in mega projects. Moreover, four semi-structured interviews were conducted among the selected construction industry professionals who are experienced in mega projects. Those interviews were used to validate the survey findings and also further helped to carry out insightful discussions on RM in mega projects. NVivo-11 was used to analyse the interview data.

3. NATURE AND CHARACTERISTICS OF MEGA PROJECTS

Mega projects are defined as those which require spending over and above department expenditure limits, require primary legalisation and are innovative or contentious (GOV.UK, 2016). The US Federal Highway Administration defines megaprojects as major infrastructure projects that cost more than US$1 billion (cited Flyvbjerg, 2001). Stoddart-Stones (1988) noted that mega projects belong to a complex management structure and can have a value of over £150M. In general, mega projects draw high levels of public and political interests as because they can have a considerable direct impact on the community, environment and budget (Flyvbjerg, 2001). It is noteworthy that politics play a key role in mega projects. The mega projects consider within this research investigation is limited to a project value over £100M.

Two of remarkable characteristics of mega projects are the high cost of construction and its associated risks. Moreover, these projects take longer time to deliver the end-product, as mainly because of finance arrangements, stakeholder influence/interest on project goals. Oliomogbe and Smith (2013) identify the 'Value in Megaprojects', construction cost, size, poor performance, risk and uncertainty as key characteristics when compared to other construction projects. In fact, these projects are highly complex, and resource intensive. They usually have social, environment and political influences, as many mega projects are of high value, the government and local councils usually play a pivotal part on such projects. Supportively, Othman (2013 cited Ruuska *et al*, 2009), explains that mega projects are usually initiated due to the impact of a wider socio, political movement. Clients of mega projects are often a government or public sector organisation, however mega projects are rarely delivered by a single entity. The designed lifespan of the product/facility is lengthy and the product is expected to be benefited by the public as most of the government funding is based on tax payers' money.

4. RISK MANAGEMENT PRACTICES IN MEGA PROJECTS

'A chance of something unpleasant will happen' is considered as 'risk' (Hopkin, 2013). In the context of construction, it is necessary to identify those likely risks as early as possible to prevent cost-time overruns. The identified risks need to be managed through appropriate mechanisms. A formalized approach must be planned and the 'nature of risk' should be managed appropriately (Hopkin, 2013) as some risks will provide

rewards to the bearers. Risk identification is a key to success and should be accomplished before the project initiation and continued throughout the life cycle of the project (Department of Energy Project Management, 2005).

Risk identification can be done through analysing the historical data of similar scenarios/projects to perceive what risks, where associated, and how those risks were dealt with and if the risks where not resolved how can they be avoided in the upcoming task. Supportively, MITRE (2013) explains that historical information from similar government programs can provide valuable insight into future risks. The quicker the risks are identified, the quicker the actions can be put in place to minimise or manage the risks (Department of Energy Project Management, 2005).

Risk management refers to the measures put in place to warrant the best solution that occurs after the event has happened and in most cases, predict the events that might happen and put actions to limit those events. ISO 31000:2009 defines risk management as 'a coordinated set of activities and methods that are used to direct an organization and to control the many risks that can affect its ability to achieve objectives' (British Standards Institution, 2009). Risk management follows key phases, which are, planning, identification, analysis (qualitative, quantitative), risk response planning, risk monitoring and control (Hilson, 2016). When the risks are identified, the process can begin to manage those risks. Risk management is an expanding field which literature has revealed that it can be used not just for protecting against loss but to accomplish larger rewards (Dey, 2012). Risk management cannot occur without risk, as risk management originates from the objectives of risk. Then the capability of that individual or organisation to successfully override those reservations of completing tasks with associated risk will have a direct effect on the ability to flourish in the task which is being completed.

Hilson (2016) identified risks as belonging to three separate categories namely, highly rated, lowly rated and risks that can only be seen in the programme, and stated that they can be managed separately. Highly rated risks related to individual projects can be those, which have complex technology, or a difficult location, Department of Energy Project Management (2005) stated that these risks would be best managed at a project level; however, programme and portfolio managers should recognise them as well. The risks which were not rated highly (lowly rated) involved low skilled staff, unreliable supplier and can appear in numerous places rather than on project. Those risks where best managed at programme or portfolio levels instead of directly with individual projects. For those risks that can be seen on the programme, these risks involve wider economy, or environment, and are best dealt within the programme. If the organisation or individual fail to identify the risks, which inhibit reaching the objectives, then these non-identified risks will become non-manageable. If this occurs, this will lead to consequences originating from the risk to be unexpected.

Once the risk has been identified, the individual or organisation will attempt to figure out why those certain risks will occur. Risk assessment includes identifying risks and the ability to rate them to establish the significant risks facing the organisation or project (Hopkin, 2012). A significant step is select whether the risks, which have been identified, shall be evaluated at the inherited level or the residual level. Inherent risk occurs without taking into consideration of the controls that are currently in place. The British Standard BS 31100 (2011) explains that risk assessment should be completed at inherent and residual level.

There are various techniques used in risk assessment, and these techniques should relate to how that certain individual or organisation interacts. For example, if the organisations were used to working in a group, workshops would be beneficial to them, unlike organisations that do not regularly work in groups. Specific actions will be undertaken to control the probability of the risks occurring or if the risk does happen what actions will be taken to minimise the effect of the risk. Risk has four treatment mechanisms in which they can be managed, namely, avoidance, reduction, transfer and acceptance (Hilson, 2016; Spacey, 2010).

The Institute of Risk Management (2016) states that risk treatment can be accomplished by for distinctive levels of authority, leadership, senior management and support level. At the leadership level the individual would ensure that the companies are following the correct protocol when risk arises, additionally promote risk treatment strategies. The senior level, the organisations methods to risk treatment are monitored and any proposals are put forward. Management level overseas the quality of risk monitoring and intervenes when certain problems arise and controls the management of the risks in line with the companies' risk strategies. Finally, the support level explains various benefits of risk treatments and their suitability to a different risk.

When considering mega projects, certain risks will arise due to the size and the cost of the project. Across the year's construction of mega-projects has offered consistent problems within periods, for instance cost overruns, delays, revenues coming up short and in some cases technical failure (de Bruijn and Leijten, 2008). Often the projects are led by planners and managers without the experience, and who will be changed throughout the lifecycle of the project, as some projects can last more than a decade. For example, the HS2 that project is expected to be fully operational by 2030 (BBC, 2016) which is about 12 years of construction. These changes of staff due to the time of the projects can weaken the leadership and cause a breakdown of communication of the project, throughout the whole structure of the organisation.

The major significant risk is cost, these projects are of high value and be more than a billion dollars as stated above. If these projects are not monitored efficiently then exceeding of the budget is more than likely. Certain projects are most likely to go over budget than others are, for example, rail projects are likely to go over budget by 45%, bridges and tunnels have an average of 35% of cost overrun and road projects come up to a figure of 20% (Garemo *et al*, 2015). Flyvbjerg *et al.*, (2003) in their study with 258 infrastructure projects that most common findings in nine out of the ten cases was that costs on mega-projects where undervalued. Furthermore, time overruns occur, this is a risk alone as this can stop the organisation from meeting key deadlines dates which have a rollover effect and in turn can cause a cost overrun. Time overruns occur due to the complexity of the project and unplanned events are not often accounted for, additionally misinformation about schedules can play a pivotal part in time overruns (Flyvbjerg, 2014).

Flyvbjerg, (2014) stated that the project scope or levels of ambition can change drastically over a period. This is a negative risk as for a project to be successful and be completed to client's satisfaction, which would expect levels of ambition to be high always and small amount of changes over the period of the project, and if there are changes there shouldn't be major alterations to the scope. As constant changes, can cause confusion on the project, which could lead to problems such as delay and cost. Complexity is one of the main characteristics of mega-projects; this characteristic brings about certain risks when undertaking projects. de Bruijn and Leijten, (2008) categorised complexity of a project into two sections, technical complexity and social complexity.

If there is full detailed design whilst work is commencing, there is less likely chance of problems being maturing. However, if the design is too complex this can be a negative point, as if the project team lacks experience with the type of project, which is being developed, problems can arise and they would not be able to manage the problem. If the project is less robust, the lack of design can bring about less predictable actions, which would affect the manageability (de Bruijn and Leijten, 2008).

Advances in technology have allowed construction sites to be safer on site and reduce any risk once the work has started, and has allowed buildings to become more complex. For instance, over the recent years BIM is being elemental in the construction industry 'with the correct use of BIM, eliminating risks is a much easier process. It allows us to consider the future and experience how the building will work before completion, thus eliminating or reducing risks' (Piff, 2013).

5. RESULTS AND DISCUSSION

The piloted online questionnaire was sent out to 282 construction industry professionals and 74 of them responded after two follow-ups. The respondents are from architecture (12%), contractor (16%), project management (20%), quantity surveying (22.7%), risk management (6.7%), and other which includes BIM managers, portfolio managers etc (22.7%), and majority (56.8%) of them are having more than 5 years of professional experience. Further analysis explains that 21.9% works in consultancy, 47.9% in contracting, 19.2% for client and 12.3% in other businesses. The UK contracting sector is the largest in the construction industry as it produces 2 million jobs and 234 thousand business annually (GOV.UK, 2013) which the majority of respondents are represented.

The respondents are currently working in several sectors including commercial (23%), industrial (27%), civil infrastructure (12.2%), residential (16.2%) and other (21.6% in oil and gas, services etc) and 60.8% works in mega projects (cost of construction exceeds £100M). Moreover, respondents have identified following risks from their projects.

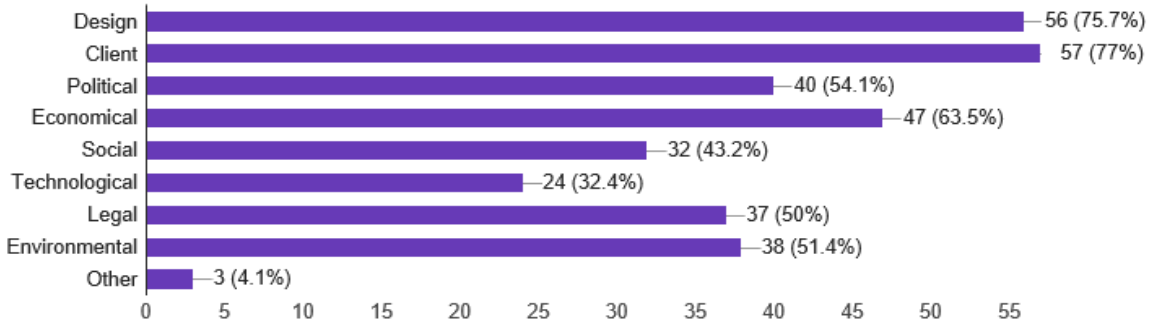

Figure 1: Types of Construction Risks in Mega Projects

The respondents agreed that 'design' and 'client' risks are the significant risks that will have an adverse effect on the project. One respondent further explained that "design can be viewed as the biggest risk as if you get the wrong design it can alter the whole project and in turn affect cost". Economic risk (cost) was the third highest (63.5%), which shows the importance of the cost when considering project through life. Literature reveals cost - time overruns as the significant risks in construction context. 77% of projects have considered a risk management strategy in place however 13.5% of projects haven't had any of the risk management (RM) strategies. The literature reveals "no construction project is risk free and risk can be managed, minimised, shared, transferred, or accepted it cannot be ignored" (Latham, 1994).

The survey findings further explain 68.5% of respondents have experience in working on mega projects. Having considered the RM strategies that in place those projects one respondents explained that they adopted "fast track design and build, had little or no risk at all, however risk did arise from design changes and mechanical and electrical engineering". Another respondent noted that the "risk management strategy in place would be determined on the level and type of risks, which have been imposed on the contractor by the contract". Majority of them agreed that the contract should share the risk this would allow the parties to manage and mitigate the risks efficiently". The survey findings overview the construction risks in general, and also likely risks in mega context. To dig the tunnel on to the risk in mega projects, the study further carried out four detailed interviews with two quantity surveyors, one civil engineer and one design manager who are having mature experience in mega projects.

The main characteristic that all interviewees shared on mega projects is that "mega projects tend to be of high value". Additionally, two of the participants gave examples of work that they are involved in or will be involved in to describe a mega project this included the Liverpool Royal hospital, which is worth £500 million, and the Manchester Airport, which will also be worth around £500 million, and the monthly valuations worth approximately £20million. Furthermore, they explained that "mega projects are not a long duration in terms of construction, they can be 2-5 years. Adding on that mega projects might take a short or long time to construct but the projects can last a long time that is their purpose, such as hospital, transports". Moreover, they agreed that mega projects are "highly complex ventures" and 'complexity' is one of key characteristics that brings risk to project stakeholders. They further mentioned that the different partnerships/stakeholders and their different interest and influence on project goals also a key characteristic when it comes to mega projects.

When evaluating the risks in mega projects all interviewees agreed that "design creates a significant risk". Design was an important risk to consider as if the design is incorrect or you do not follow the design, then this could fail the whole project, leading to more cost. Moreover, they perceived that cost is an important element as that what makes the project ‘tick over’ without money the project would happen in the first place. The two quantity surveying participants viewed economy as very important, some of the participants referred to ‘Brexit’ when discussing the economic risk as you are never 100% what can influence the cost. The third risk that the participants viewed as high/significant was legal risk. Legal risk was not one of the significant risk found in the literature review or in fact considered a risk, and half of the participants in the questionnaire considered legal risk considered as a risk to a project. Between the interviewees environmental risk was high and significant as they viewed that legal regulations that must be followed before construction is started and throughout the construction.

All of the interviewees participated in this study concluded that risk management was pivotal in a mega project. The main reasons were that having an effective risk management strategy in place would benefit the parties involved in the project, over the life of the project. Risk must be eliminated and efficiently managed as time and costs of the project can easily escalate. One of the key risks that must be managed is health and safety, which is pivotal to a successful project. Additionally, risk management strategies could depend on the project value as, the value of the project increase the project risk also increases.

Risk strategies as identified in the data is that they need to be identified analysed and the risks should be treated as similar strategy to that of the ISO 31000 (2009). As well as having the main risk management strategy within the project, communication is very valuable as this gives the opportunity for different departments and/or professions to raise risk that others could have missed out on or did not recognise as they do not have previous experience with certain risks. Communication is granted through the project performing meetings at regular intervals so that risks can be identified, analysed and mitigated. Three out of the four interviewees noted the importance of a risk register.

Risk management strategy provides the opportunity for the project to keep track of all risk whether they have happened, will happened or currently happen. During meetings at regular intervals, within the meeting the individuals would refer back to the risk register. It is important that all risk is recorded no matter how small or big the risk is, as every small risk has the potential to develop to a major risk. Additionally, motivation of staff was important, as if the staff is motivated they will carry the jobs professionally and diligently and in turn reduce risk. One of the participants stated that to make sure a mega project is successful participant suggested that different leaders are introduced at different points of the project, as if they have experience with certain parts of a project, risk will be reduced. This is an important statement that the research analysed, as if you have one leader throughout one mega project, who probably has not dealt with certain aspects of the project it would be advised to bring another person in who has experience with that point of project, risk can arise if the leader lacks experience to deal with certain risks.

Two of the interviewees agreed that early stages of the project are vital if risk management is to play a key part in the client's investment. 'Earlier the better' as putting the correct systems in the first place will ensure the project will run efficiently, how the project will be run, how to deal with risks if that is all managed in the beginning they will be no need to panic when a risk does arise or not know how to deal with a new circumstance within the project.

Out of the two interviewees who agreed that earlier the better, one of them did state that risk management is vital throughout the whole process of the project. This was stated by the other half of the participants who mentioned that risk management plays a part in the beginining, middle and end of the project. Participants agreed that it was important as you always have to monitor risk there is not a point where risk management is pivotal as you can never be certain when the risk will arise. The recurring theme was that risk management is a process that occurs throughout the project life cycle, hence one cannot choose only a specific point to concentrate on, as this can lead to the ignoring of at other points of the project, and risk can arise when they are least expected.

6. CONCLUSIONS AND RECOMMENDATIONS

Mega projects can be defined as projects that are complicated, worth high value and can affect the broader public. Mega projects have the effect of creating many jobs during construction and after the construction has been completed. Mega projects are important to society as they have contributed to the construction of infrastructure, commercial and healthcare establishments. Main characteristics of mega projects involve high value, predominately medium – long duration of construction, complex design, and the large participation of stakeholders involved.

The risks that are associated with mega projects include political, economic, social, technology, legal and environment. Political risks related to mega projects is that when political acts affect construction, as recently the 'Brexit' vote, can cast doubt on future projects, or projects which are currently undergoing. Major economic risk with mega projects is the budget, as stated by Garemo *et al* (2015) 45% of rail projects are likely to go over budget. As in this study it has stated that the HS2 has increased budget since the first budget was revealed. In construction, cost is major factor to consider and it was of the elements in a project that has to be managed efficiently or cost can spiral out of control. Social risk is not one of the significant problems but can

still manage to cause major risk to a project, for example through public demonstrations. Technological risk is probably the least significant risk taking into consideration form the literature review, questionnaires and interviews. However, the construction industry is at risk to fall further behind in technology if they do invest more money into technology. Taking into consideration the data analysis, legal risk is not a significant risk but it is still an important risk to consider when undertaken projects. This is due to certain changes in law having an impact on construction process and products. Furthermore, environmental risk concerns all aspects of life, and it is no different in construction. There is a high environmental risk as found in the data analysis and literature review. What is worse is that there have been less investments in the solutions that can help with the environment, as reported by Anders *et al* (2011) global investment is down, and this could be important when reducing CO_2 emissions.

Design is an important risk to monitor due to the fact that if the design is wrong or not followed accordingly this can in turn increase the cost of the project. Cost is one of the significant aspects to consider which can determine a projects success, as costs controls the project. If costs are not properly managed at the beginning of the project this can cause further problems later on in the project.

Due to mega projects having risks, risk management strategies must be put in place to minimise the effects of this risks. As found in the literature review and the data analysis the best method of risk management is to first identify the risk, analyse the risk and mitigate the risk. Different construction projects will interpret that method the way they see best fits to their objectives.

RM is an important consideration for every project. The market is highly driven for mega sector and massive investments. Managing risk in mega projects will positively contributes towards the sustainability agenda (social, environmental and economic). Therefore, what is new is the policy level implications and continuous review of risks in mega projects. Where the service is complex, where there are many interdependencies and interfaces, or where the risks are high, then a collaborative approach should be considered. In this sense the new approaches such as BIM should be much better integrated in to the RM process in mega projects.

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